Annals of R.S.C.B., ISSN: 1583-6258, Vol. 25, Issue 6, 2021, Pages. 981-987
Received 25 April 2021; Accepted 08 May 2021.

Benefits of Short Structured Exercise Progeam in Obese Women with Polycystic Ovary Syndrome

PRIYA KUMARI[1], DR. P SENTHIL SELVAM[2], DR. M.S SUNDARAM[3], DR. M MANOJ ABRAHAM[4], DR. TUSHAR J PALEKAR[5], MAHALAKSHMI. G[6], M. SANDHYA[7], C. RAJESWARI[8]

[1]Assitant Professor, Vels University, School of Physiotherapy, Rajiv Gandhi Salai, Near Navalur, Thalambur, OFF (OMR), Chennai-600130
[2]Professor and HOD, Vels University, School of Physiotherapy, Rajiv Gandhi Salai, Near Navalur, Thalambur, OFF (OMR), Chennai-600130
[3]Professor, Vels University, School of Physiotherapy, Rajiv Gandhi Salai, Near Navalur, Thalambur, OFF (OMR), Chennai-600130
[4]Professor and Principal, K G college of Physiotherapy, Saravanampatti, Coimbatore-641035
[5]Professor and Principal, Dr. D.Y Patil college of Physiotherapy, Pune-411018
[6]MPT student, Vels University, School of Physiotherapy, Rajiv Gandhi Salai, Near Navalur,Thalambur, OFF (OMR), Chennai-600130
[7]Assistant Professor, Vels University, School of Physiotherapy, Rajiv Gandhi Salai, Near Navalur, Thalambur, OFF (OMR), Chennai-600130
[8]Research Scholar MPT, Vels University, School of Physiotherapy, Rajiv Gandhi Salai, Near Navalur, Thalambur, OFF (OMR), Chennai-600130

Abstract
Background: Polycystic ovarian syndrome is a common endocrine disorder in women of reproductive age, which is often associated with insulin resistance and obesity. This study focuses on effects of combined exercises training in a short period of time as a structured exercise program in women, diagnosed with polycystic ovaries.
Aim: to evaluate the effectiveness of short term structured exercise on anthropometric and cardiovascular parameters in obese women with a diagnosis of polycystic ovary syndrome
Study Setting and Design: Experimental study on convenient sample selection, vinayaga mission hospital.
Materials and Methods: total 30 samples (Training group 15, control group 15). Training group received structured exercise program (8weeks) and lifestyle modification advices, and the control group lifestyle modification. Anthropometric and cardiovascular parameters were evaluated during pre and post study period of 8 weeks.
Statistical Analysis used: SPSS Software.
Results and Conclusion: Following 8 weeks of exercise, the training group consumed significantly higher oxygen and improved their quality of life with PCOS significantly. The corresponding values of the control group did not vary significantly in the 8 weeks experiment. Thus, a short-term regular physical activity can improve anthropometric and cardiovascular parameters in obese women with polycystic ovary syndrome.

Keywords: Anthropometric and Cardiovascular Parameters, PCOS, Structured Exercise Program

Introduction

Polycystic ovarian syndrome is a major public health concern affecting women; especially in the reproductive age group worldwide. Polycystic ovarian syndrome (PCOS) is a reproductive – metabolic disorder primarily characterized by hyperandrogenism and chronic anovulation[3] disrupts HPO axis function. Depending on the diagnostic criteria known as ROTTERDEM CRITERIA[7], the prevalence of PCOS is roughly 6 to 20% of females. The multifaceted clinical evidence of PCOS comprises of hyperandrogenism, menstrual dysfunction, infertility, antenatal complications, increasing insulin resistance and increasing the prevalence of obesity and abdominal obesity[11].

As PCOS enact at the risk factors in developing impaired glucose tolerance and cardiovascular disorders, also shows the elevation in triglycerides and low density lipoprotein cholesterol levels (LDL), declining the high density lipoprotein (HDL) cholesterol levels in the blood. The prevalence of obesity is higher in PCOS women (25 % to 70 %) than non-obese women (25 %). In obese and non- obese women with PCOS, frequently show excessive body fat and central adiposity[1]. PCOS is a leading cause of anovulation, oligomenorrhea and amenorrhea, infertility, miscarriage, depression, anxiety, body image concerns and health-related quality of life in a certain obese population.

A Comprehensive understanding of the pathogenesis of PCOS would enable for earlier diagnosis of girls at high risk of developing PCOS[7]. Individualized treatment approaches implemented on time can increase overall control of PCOS during puberty, prevent related comorbidities, and enhance quality of life.

Weight-independent (intrinsic) IR[12] is strongly implicated to the prevalence of the syndrome, contributing significantly to the reproductive and metabolic complications as IR becomes a primary target. Adolescents with clinical signs of androgen excess and oligomenorrhea/amenorrhea are considered "at risk for PCOS" even before a definitive diagnosis. Education, healthy lifestyle interventions, and therapeutic interventions targeting symptoms are being used to manage both those who are at risk for PCOS and for those with a confirmed PCOS diagnosis[4]. In women with PCOS, lifestyle intervention is considered first-line therapy as studies have proven that it enhances both metabolic and reproductive manifestations of the syndrome. Despite the potential benefits of exercise in PCOS, there is a lack of understanding about the type and intensity of exercise required to improve outcomes in this population. High intensity interval training (HIT) has been shown to have a greater impact on IR in adults at risk than moderate continuous training. Consequently, strength training (ST) has been found to improve insulin sensitivity in overweight/obese, sedentary men and women, with a prevalence of 31.4 % in men and 16.4 % in women[18].

Aerobic exercise increases peak oxygen consumption (VO^2 peak), which is closely related to total body fat percentage (BF %); aerobic exercise is also a powerful weight loss strategy, particularly for body fat loss [4, 24]. Exercise duration and intensity are typically manipulated when establishing a suitable weight loss program. Moderate aerobic exercise for at least 150 minutes per week may work on improving metabolic syndrome, risk factors including body composition, insulin resistance, and glycated hemoglobin (HbA1c)[8]. Exercise expenditure, however, is not the only factor responsible for weight loss in varying exercise intensities. Only a few studies have demonstrated that high-intensity exercise training can effectively reduce body and abdominal fat. When energy expenditure is held constant, high-intensity exercise is more beneficial than low-intensity exercise for improving body composition and reducing abdominal fat.

Furthermore, a randomized controlled trial found that high-intensity interval training was just as effective as low-intensity endurance exercise training in reducing body weight and fat. This finding suggests that increasing the intensity of exercise is more effective in improving body composition. Long-term evidence from randomized controlled trials on the effect of exercise duration with varying intensities and energy expenditures on body composition, on the other hand, it is limited. More positive metabolic health outcomes are now being reported for HIIT when compared to recommended lower-intensity regimes, including the improvement glycemic control and cardio-respiratory fitness in clinical populations and amongst women with PCOS. Only one randomized controlled trial (RCT) in women with PCOS was conducted to evaluate the benefits of HIIT, in which they compared a resistance-training program to a control group. They observed improvements in insulin sensitivity and high-density lipoprotein cholesterol, and also a decrease in fat percentage, after 10 weeks of exercise regime.

Greenwood, et.al [23] was the first to investigate the effect of varying intensities of exercise on women with PCOS in a cross-sectional study. The findings of these studies enhanced the remarkable health benefits of vigorous exercise, including lower BMI and HOMA-IR and higher levels of HDL and sex hormone binding globulin in PCOS WOMEN, when compared to moderate exercise. Some studies have discovered that 60 minutes of physical exercise a week associates with a 22% reduction in the odds ratio of metabolic syndrome; (95% confidence interval)[23]. Although, these studies shown that high-intensity exercise is beneficial, more objective data and promoting the greatest health benefits for PCOS women.

A research found that high intensity training is much more effective than moderate intensity exercise or standard care (unsupervised lifestyle intervention) in enhancing metabolic (body composition and insulin sensitivity), reproductive (anti-müllerian hormone [AMH] and steroid profiles), and mental wellbeing (depression and health-related quality of life) in women with PCOS[19]. Identifying the initiating mechanisms is difficult due to the complex interwoven pathophysiology. The majority of clinical evidence available in adult women conveys results and effects. Although the Rotterdam criteria are widely agreed in adult women, different diagnostic criteria for PCOS in young women have been defined.

Lifestyle intervention in PCOS is challenging. Exercise seems to have the potentials to be more sustainable. Since it has been documented that regular physical activity increases surrogate markers of IR and PCOS, it is well accepted that lifestyle changes such as exercise and good diet reduce the risk of developing type 2diabetes[2]. This is highly relevant for overweight and obese women with PCOS and insulin resistance, as their risk of developing diabetes is 7-10 times higher than for women of average weight with PCOS. Exercise training

improves endothelial function in patients with risk factors equivalent to women with PCOS. Obese PCOS patients who lose weight have lower levels of circulating androgens and higher levels of SHBG, which increases their menstrual cycle and fertility rates. The PCOSQ-50 is a true and accurate instrument for assessing the quality of life of PCOS women[24].

According to the international evidence-based guideline for the assessment and management of PCOS, the symptoms should be assessed, managed, and the health professionals should be aware of impact of PCOS on emotional wellbeing and on quality of life (QoL). Aerobic physical training improves the glycemic regulation, visceral adiposity, sexual function, and QoL in PCOS[14].

According to the International evidence-based guideline for the assessment and management of PCOS of 2018, these symptoms should be assessed, managed, and the health professionals should be aware of impacts on emotional wellbeing and on QoL. Aerobic physical training improves glycemic regulation, visceral adiposity, sexual function and QoL in PCOS[14]. However, few studies have assessed the effect of exercise on body image in people with PCOS. According to Liao et al. a self-directed brisk walking program lowered depression and self-image discomfort[26]. Systematic reviews in other populations revealed that physical activity is a viable and successful strategy for negative body image.

Exercise also improves the ways in which women perceive their body composition. Body image is a combination of cognitive and affective, perceptual, and behavioral components, besides a multitude of faces that depict how one's body thinks and feels, one's perception of the size and shape of one's physical self as well as their bodily parts, and one's body activities that people perform for the purpose of verifying, preserving, modifying, or concealing one's body(Teede et al.)[26].

Hubbard, et.al.[26] used various scales and instruments to analyze the effect of three different types of exercise (resistance, aerobic, and interval circuit) on body image. The findings revealed that aerobic and resistance exercises improve body image from pre- to post-exercise, but a single resistance exercise session can only improve state body image.

Methods and Materials

- **STUDY DESIGN**: Experimental study
- **STUDY TYPE**: Comparative study
- **STUDY DURATION**: 8 weeks
- **STUDY SETTING**: Vinayaga mission hospital.
- **SAMPLE SIZE**: 30 samples.

Sample Selection

Convenient sampling

Inclusion Criteria

- Age: 18 to 34 years
- BMI– more than 28.5 kg/m^2
- Rotterdam criteria (Presence of 2 of the 3 criteria): Amenorrhea / oligomenorrhea, polycystic ovaries (clinical findings), hyperandrogenism.

Exclusoin Criteria

- Endo-crinological diseases like diabetes, thyroid, adrenal, pituitary gland dysfunction.
- Cardiovascular, hepatic/pulmonary diseases
- History of orthopedic or other physical symptoms which limits exercise performance
- Regularly exercised within last 6 months.
- Ongoing pregnancy

Procedure

Totally 30 patients (aged 18-34) were taken to complete the study who are all fulfilled the inclusion criteria, Rotterdam criteria with the BMI > 28.5 kg/m^2. The 30 cases were divided into two groups under randomized selection as experimental group (ExG) (n=15) and control group (CG) (n=15). The control group receives only the lifestyle modification advises with no intervention. The training group receives circuit model of exercise training include aerobic training and high intensity interval training for the duration of 8 weeks. Anthropometric and cardiovascular parameters and also PCOSQOL questionnaire are being recorded before and after the intervention both training and control group.

Annals of R.S.C.B., ISSN: 1583-6258, Vol. 25, Issue 6, 2021, Pages. 981-987
Received 25 April 2021; Accepted 08 May 2021.

Intervention

Experimental group (ExG)

- Experimental group includes 15 patients. Heart rates, respiratory rate, max VO^2 are recorded for the statistical reports.
- Aerobic training[1]:
    - A step was used foe aerobic training
    - 1 to 4 weeks –10 cm high step
    - 5 to 8 weeks – progress to 15 – 20cm high step
    - 20 to 30 minutes of duration per session
    - Achieving 80% of the maximum heart rate.

- HIIT training
    - Stationary Bicycling
    - 2 session/ week –12 *1 HIIT, with 1 minute active recovery
    - One session/week –8 *4 HIIT, with 2 minutes active recovery.

Control Group (CG)

The group includes 15 numbers of patients who are all 100% fulfilled the inclusion criteria. They received only the lifestyle modification advices with their daily living activities are being continued for the 8 weeks study duration. Pre and post study anthropometric and cardiovascular parameters are recorded.

Result

This survey provided demographic data from 40 patients aged 18–24 years with a BMI greater than 28.5 kg/m^2. Of these 40 patients, 30 met inclusion criteria and 10 were excluded owing to their in-fulfillment of inclusion criteria. As a result, the study was completed by 15 patients in the training group and 15 patients in the control group. The Rotterdam criteria of PCOS were fulfilled by all 30 patients: To ensure their willingness to participate in a study, all patients were given a written consent form. By convenient sampling method, the 30 patients who were included in the study were divided into two groups: experimental group (ExG) (A) and control group (CG) (B). Anthropometric measurements such as weight, BMI, waist and hip circumference, waist-height ratio, and cardiovascular parameters such as heart rate (HR), respiratory rate (RR), systolic blood pressure (SBP), diastolic blood pressure (DBP), and maximum amount of oxygen consumption were evaluated in all 30 cases.

The anthropometric and cardiovascular parameters of training group and control group were listed based on the statistical data analysis in the above given tables. The baseline parameters between the two groups did not significantly differ. In the training group several parameters show the significant difference within the group after 8 weeks of exercise training, such as weight, BMI, waist and hip circumference, waist-height ratio (anthropometric parameters) and heart rate, respiratory rate systolic and diastolic blood pressure, max vo^2 values. In the control group, the anthropometric and cardiovascular parameters were no significantly differs during 8 weeks of exercise program. The significant differences in weight, waist circumference are higher in training group than in the control group. PCOSQOL questionnaire shows a minor significance in training group (average = 4.52) than in the control group (average = 4.99) in 8 weeks study duration, as it analyses the obese women's perception on PCOS and its impact on their quality of life.

Discussion

We have investigated into the efficacy of an 8-week structured training regimen on obese PCOS patients. Many studies have found that exercise training enhances cardiopulmonary functional capacity and metabolic syndrome parameters in overweight PCOS patients; however, the purpose of this study is to assess the effects of scheduled exercise program in obese PCOS patients. We observed that 8 weeks of structured exercise was beneficial in optimizing anthropometric, cardiovascular, and metabolic parameters, along with regulating menstrual cycles in obese PCOS patients.

Few studies on PCOS have reported that the beneficial outcomes from exercise training are being related to the reduction in the risk of cardiovascular dysfunction and delays the induction of metabolic syndrome activation of proteins in insulin signal transduction in skeletal muscles. Therefore, by following a systematic exercise program, PCOS patients can improve their cardiopulmonary functioning capacity and insulin sensitivity. Modalities other than fitness have been suggested for the treatment of PCOS.

In addition, most PCOS studies have found that along with dietary plan lifestyle modifications should be included in the treatment of these patients. However, there is no consensus on the basic variables of exercise training, including type, intensity, duration, frequency, and progression, which is then used to evaluate that, whether effects of a training program are preserved even after cessation of study period.They concluded that 12 weeks of non-exercising resulted in the massive loss of all beneficial modifications obtained from the exercise program. As a result, in order to reap the benefits of exercise, it is essential to maintain practicing throughout one's life. Though some observers have examined the impact of diet plan on PCOS , we found that,structured exercise was indeed beneficial, at least in the short term.

Kong, Z, et.al
HIIT in various ways has been shown to greatly improve V2 peak and aerobic ability. The current research discovered that after five weeks of this low-volume HIIT protocol, the relative V 2peak and PPO were increased by 7.9 percent and 13.8 percent, respectively, which is consistent with a meta-analysis that observed an average of 7.3 4.8 percent improvement in V 2peak. 19th.[19]. In accordance with previous studies, also did not find any additional effect caused by the HIIT protocol when compared to MICT.

Santos, I. K. D, et.al
Furthermore, HIIT is perceived to be easier than MICT. Since the HR monitored during the exercises were analogous (164 8 bpm in HIIT versus 160 12 bpm in MICT), the significantly lower RPE reported in the HIIT group may be attributed to the interval exercise mode of submaximal exercise strength training.The game-like nature of HIIT, which differs between short sprints and recovery periods, may assist in lowering the perception of effort. Collectively, in comparison to MICT, the current HIIT protocol is a more time-efficient and straightforward exercise mode for enhancing cardiorespiratory fitness in obese females[17].

The present study has evaluated the benefits of short term structured exercise program with combined aerobic and high intensity interval exercise training shown the improvement in anthropometric and cardiovascular functions in inactive obese young women with polycystic ovary syndrome as this protocol enhances their physical activity and quality of life and also in managing and reducing the risk of worsening of PCOS symptoms.

Conclusions
PCOS is a metabolic disorder that influences on body structure, physical activity, and mental health in the majority of people who adopt sedentary lifestyles. High-intensity short-term exercise assists obese women in managing the symptoms of PCOS, resulting in a greater increase in physical health and quality of life. Short term training program includes the high intensity interval training along with aerobic training as a circuit mode of exercise training can improve the anthropometric parameters include weight, waist and hip circumference, WHtR and the cardiovascular parameters include maximum oxygen consumption during the total period of 8 weeks exercise training.

As high intensity interval training provides a greater impact on the improvement of body composition in obese women along with increasing the cardiovascular fitness and quality of life in polycystic ovary syndrome. From the statistical analysis it was concluded that a combined circuit training of high intensity interval training and aerobic training provided the improvement in physical activity, emotional well-being and quality of life in obese women diagnosed with polycystic ovary syndrome. Thus, Short-term regular exercise programs can lead to improvements in anthropometric, cardiovascular, and metabolic parameters of overweight/ obese women.

REFERENCE
1. Volkan Turan, Ebru Kaya Mutlu, Ulas Solmaz, Atalay Ekin*, Ozge Tosun (2015), Benefits of short-term structured exercise in non-overweight women with polycystic ovary syndrome: a prospective randomized controlled study.
2. Pothiraj Pitchai*, S. R. Sreeraj , Parmar Reema Anil (2016):Awareness of lifestyle modification in females diagnosed with polycystic ovarian syndrome in India: explorative study
3. Seema Patel, et.al (2018): Polycystic ovary syndrome (PCOS), an inflammatory, systemic, lifestyle endocrinopathy. The Journal of steroid biochemistry and molecular biology, 182, 27-36.
4. Witchel, S. F., Oberfield, S. E., & Peña, A. S. (2019). Polycystic ovary syndrome: pathophysiology, presentation, and treatment with emphasis on adolescent girls. Journal of the Endocrine Society, 3(8), 1545-1573.

5. Dadachanji, R., Shaikh, N., & Mukherjee, S. (2018). Genetic variants associated with hyperandrogenemia in PCOS pathophysiology. Genetics research international, 2018.
6. R. Vidya Bharathi a , S. Swetha a , J. Neerajaa a , J. Varsha Madhavica, et.al (2017): An epidemiological survey: Effect of predisposing factors for PCOS in Indian urban and rural population, Life sciences, 236, 116940.
7. Kahal, H., Kyrou, I., Tahrani, A. A., & Randeva, H. S. (2017). Obstructive sleep apnoea and polycystic ovary syndrome: a comprehensive review of clinical interactions and underlying pathophysiology. Clinical endocrinology, 87(4), 313-319.
8. Al-Jefout, M., Alnawaiseh, N., & Al-Qtaitat, A. (2017). Insulin resistance and obesity among infertile women with different polycystic ovary syndrome phenotypes. Scientific reports, 7(1), 1-9.
9. Chiu, C. H., Ko, M. C., Wu, L. S., Yeh, D. P., Kan, N. W., Lee, P. F., ... & Ho, C. C. (2017). Benefits of different intensity of aerobic exercise in modulating body composition among obese young adults: a pilot randomized controlled trial. Health and quality of life outcomes, 15(1), 1-9.
10. Teede, H. J., Misso, M. L., Boyle, J. A., Garad, R. M., McAllister, V., Downes, L., & Woolcock, J. (2018). Translation and implementation of the Australian‐led PCOS guideline: clinical summary and translation resources from the International Evidence‐based Guideline for the Assessment and Management of Polycystic Ovary Syndrome. Medical Journal of Australia, 209, S3-S8.
11. Hiam, D., Patten, R., Gibson-Helm, M., , A., McIlvenna, L., Levinger, I., ... & Stepto, N. (2019).). The effectiveness of high intensity intermittent training on metabolic, reproductive and mental health in women with polycystic ovary syndrome: study protocol for the iHIT-randomised controlled trial. Trials, 20(1), 1-9.
12. Woodward, A., Broom, D., Dalton, C., Metwally, M., & Klonizakis, M. (2020). Supervised exercise training and increased physical activity to reduce cardiovascular disease risk in women with polycystic ovary syndrome: study protocol for a randomized controlled feasibility trial. Trials, 21(1), 1-8.
13. Williams, S., Sheffield, D., & Knibb, R. C. (2018). The Polycystic Ovary Syndrome Quality of Life scale (PCOSQOL): development and preliminary validation. Health psychology open, 5(2), 2055102918788195.
14. Boivin, M. J., Fatehi, F., Phillips-Chan, A. E., Richardson, J. R., Summers, A. N., & Foley, S. A. (2020). Exploratory study of a screening measure for polycystic ovarian syndrome, quality of life assessment, and neuropsychological evaluation. BMC Women's Health, 20(1), 1-12.
15. Moran, L. J., Tassone, E. C., Boyle, J., Brennan, L., Harrison, C. L., Hirschberg, A. L., & Teede, H. J. (2020). Evidence summaries and recommendations from the international evidence‐based guideline for the assessment and management of polycystic ovary syndrome: Lifestyle management. Obesity Reviews, 21(10), e13046.
16. Kite, C., Lahart, I. M., Afzal, I., Broom, D. R., Randeva, H., Kyrou, I., & Brown, J. E. (2019). Exercise, or exercise and diet for the management of polycystic ovary syndrome: a systematic review and meta-analysis. Systematic reviews, 8(1), 1-28.
17. Lim, S., Smith, C. A., Costello, M. F., MacMillan, F., Moran, L., & Ee, C. (2019). Barriers and facilitators to weight management in overweight and obese women living in Australia with PCOS: A qualitative study. BMC endocrine disorders, 19(1), 1-9.
18. Santos, I. K. D., Nunes, F. A. S. D. S., Queiros, V. S., Cobucci, R. N., Dantas, P. B., Soares, G. M., ... & Dantas, P. M. S. (2021). Effect of high-intensity interval training on metabolic parameters in women with polycystic ovary syndrome: A systematic review and meta-analysis of randomized controlled trials. Plos one, 16(1), e0245023.
19. Miguet, M., Fearnbach, N. S., Metz, L., Khammassi, M., Julian, V., Cardenoux, C., & Thivel, D. (2020). Effect of HIIT versus MICT on body composition and energy intake in dietary restrained and unrestrained adolescents with obesity. Applied Physiology, Nutrition, and Metabolism, 45(4), 437-445.
20. Kong, Z., Sun, S., Liu, M., & Shi, Q. (2016). Short-term high-intensity interval training on body composition and blood glucose in overweight and obese young women. Journal of diabetes research, 2016.
21. Clark, A., Annie, B., DeRevere, J. L., & Astorino, T. A. (2019). Effects of various interval training regimes on changes in maximal oxygen uptake, body composition, and muscular strength in sedentary women with obesity. European journal of applied physiology, 119(4), 879-888
22. Stepto, N. K., Patten, R. K., Tassone, E. C., Misso, M. L., Brennan, L., Boyle, J., ... & Moran, L. J. (2019). Exercise recommendations for women with polycystic ovary syndrome: is the evidence enough?. Sports Medicine, 49(8), 1143-1157.
23. Yuvarani, G., Banu, S., Tharani, G., Kamatchi, K., & Princy, F. Comparison of Short-Term Structured

Exercise In Non-Over Weight and Overweight Subjects With Polycystic Ovarian Syndrome.(2021). Int. J. Life Sci. Pharma Res, 11(1), L155-160.

24. Jafari, S., & Taghian, F. (2020). The Effect of Aerobic Exercise Training on Biochemical and Inflammatory Markers among Young Females Suffering from Polycystic Ovary Syndrome. Journal of Midwifery and Reproductive Health, 8(2), 2194-2202.
25. Ribeiro, V. B., Kogure, G. S., Lopes, I. P., Silva, R. C., Pedroso, D. C. C., de Melo, A. S., ... & Dos Reis, R. M. (2020). Effects of continuous and intermittent aerobic physical training on hormonal and metabolic profile, and body composition in women with polycystic ovary syndrome: A randomized controlled trial. Clinical endocrinology, 93(2), 173-186.
26. Corres, P., MartinezAguirre-Betolaza, A., Fryer, S. M., Gorostegi-Anduaga, I., Arratibel-Imaz, I., Aispuru, G. R., & Maldonado-Martín, S. (2020). Long-term effects in the EXERDIET-HTA study: Supervised exercise training vs. physical activity advice. Research quarterly for exercise and sport, 91(2), 209-218.
27. Kogure, G. S., Lopes, I. P., Ribeiro, V. B., Mendes, M. C., Kodato, S., Furtado, C. L. M.,& Dos Reis, R. M. (2020). The effects of aerobic physical exercises on body image among women with polycystic ovary syndrome. Journal of affective disorders, 262, 350-358.
28. Randeva, H. S., Tan, B. K., Weickert, M. O., Lois, K., Nestler, J. E., Sattar, N., & Lehnert, H. (2012). Cardio metabolic aspects of the polycystic ovary syndrome. Endocrine reviews, 33(5), 812-841.
29. Zhang, H., Tong, T. K., Qiu, W., Zhang, X., Zhou, S., Liu, Y., & He, Y. (2017). Comparable effects of high-intensity interval training and prolonged continuous exercise training on abdominal visceral fat reduction in obese young women. Journal of diabetes research, 2017.
30. Vizza, L., Smith, C. A., Swaraj, S., Agho, K., & Cheema, B. S. (2016). The feasibility of progressive resistance training in women with polycystic ovary syndrome: a pilot randomized controlled trial. BMC sports science, medicine and rehabilitation, 8(1), 1-12.
31. Kamel, Mohamed, and Safaa Salah Ismail. "Effects of Oil Massage Therapy on Anthropometric Parameters and Behavioral State of Stable Low Birth Weight Neonates." IMPACT: International Journal of Research in Applied, Natural and Social Sciences (IMPACT: IJRANSS) 4.6 (2016) 33-42
32. Premkumari, Ravindra Yaranal, Sunil Shirwal, and M. Veerangouda. "Study on Anthropometric Dimensions of Women Agricultural Workers of Hyderabad Karnataka Region." International Journal of Agricultural Science and Research (IJASR) 6.3 (2016): 359-364.
33. Ismail, Jawad Mohammad, Majid Kadhum Hussain, and Hamza Jasim Mohammad. "Common Variants In The Adiponectin Receptor 2 (Adipor2) Gene Is Associated In T2dm Patients In With And Without Cardiovascular Disease And Adiponectin Levels." IMPACT: International Journal of Research in Applied, Natural and Social Sciences (IMPACT: IJRANSS) 4.4 (2016) 81-88
34. Abbas, Hamed Jadooa, and Jawad Mohammad Ismail. "Association of Adiponectin Levels in Iraqi Patients With Type 2 Diabetic and Prediction of Cardiovascular Complications." TJPRC: International Journal of Diabetes & Research (TJPRC: IJDR) 2.1 (2016) 1-8.
35. Saidunnisa, Begum, Shariff Atiqulla, and Ghufran Ayman. "Prevalence of Polycystic Ovarian Syndrome among Students of RAK Medical and Health Sciences University United Arab Emirates." International Journal of Medicine and Pharmaceutical Science (IJMPS) 6.1 (2016) 109-118.